

## PHYSICAL FORCES

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**Impact:** something hits the object or the object collides with something else.  
Impact is short lived but highly concentrated

**Shock:** an abrupt strong impact force resulting in large deformations and strain

Stress is force and strain is deformation due to that force.

**Normal Stress:** Stress that acts perpendicular to a surface.

**Compression:** Stress that acts to shorten an object.

**Tension:** Stress that acts to lengthen an object.

**Shear:** Stress that acts parallel to a surface

**Shock** is an abrupt strong impact force resulting in large deformations and strain. Shock results in the production vibration, fracture in brittle materials and deformation (in more elastic materials).

**Vibration:** is the oscillating motion of an object relative to a fixed point.

Characteristics which define vibration are:

- Frequency
- Displacement
- Velocity
- Acceleration
- Phase

**FREQUENCY:** describes the oscillation rate, it is the number of wave cycles that occur in one second.

**PERIOD** of a vibration is the amount of time it takes to complete one full wave cycle.

**AMPLITUDE** describes the severity or magnitude of the vibration. Amplitude depends upon

- the size of the vibratory movement (Displacement)

- the speed of the movement (Velocity)
- the force associated with the movement (Acceleration)

Vibration can be quantified by several descriptors:

-The raw signal, (often recorded and used) such as in the light line which is an instantaneous vibration velocity which fluctuates from positive to negative around a zero line. The maximum velocity point is the peak particle velocity. But most often the vibration is random and mixed.

-Spectrum: a graphical display of the frequencies at which a source or object is vibrating, together with the amplitudes of the component at these frequencies.

How do object vibrate?

Because of geometry, mass and elasticity most objects can vibrate at many different frequencies. The lowest frequency is called the natural frequency. All of these frequencies can be called resonant frequencies but this is usually refers to the higher ones.

There are several responses objects can have:

Transmission: object will vibrate at same frequency and amplitude as the source if the vibrational frequency of the source is lower than the objects natural frequency of vibration

Attenuation: if the source vibration frequency is greater (higher) than the object the object seems to be still.

Resonance: if the source natural frequency matches the natural frequency of the source, the amplitude of the resonant frequency vibration will increase. This is resonance of the object.

## ***MEASURING:***

Types and Sources of vibration:

**Continuous vibration**

**Impulsive vibration**

**Intermittent vibration**

HOW DO OBJECTS MOVE AND HOW IS THAT RELATED TO DAMAGE  
DUE TO VIBRATION

**Fracture/distortion**

**Fatigue:** for fatigue to occur the critical threshold must occur which may be in the range of millions of cycles, but it is very hard to quantify.

**Abrasion:** Occurs whenever two surfaces, under a degree of compressive load, move relative to one another across the plane of contact. Things rub against one another. The degree of damage due to abrasion depends upon pressure, surface durability and the surface topography.

Building a crate:

It is essential when designing and building a transport package (box or crate) that the characteristics of the environment which this will be sent into are defined and the material characteristics of the object, as well as its fragility factor, be defined as much as possible.